3

Using Dietary Reference Intakes in Planning Diets for Groups

SUMMARY

The framework for group planning presented in this chapter focuses on the distribution of usual nutrient intakes as the basis for planning. This chapter describes the framework as it applies to planning for groups that are homogeneous in regard to life stage and gender, while Chapter 4 presents an approach to planning for heterogeneous groups.

The overall goal of planning for groups is to achieve usual intakes in the group that meet the requirements of most individuals, but are not excessive. This is accomplished by combining information on the group's nutrient requirements with information on its usual nutrient intakes. This information is used to plan for a usual nutrient intake distribution in which intakes will meet the requirement of all but a specified proportion of the group. This framework importantly shifts the focus of planning away from past practices of using dietary recommendations or Recommended Dietary Allowances to decide what to serve, toward what is ultimately desired in terms of the distribution of usual intakes as measured by actual consumption. To apply the framework presented here, an acceptable prevalence of inadequacy must be defined and the distribution of usual intakes in the group must be estimated. The target usual intake distribution can then be determined by positioning the distribution of usual intakes relative to the Estimated Average Requirement or nutrient requirement distribution so as to achieve the desired prevalence of inadequacy. When positioning the distribution,

the prevalence of intakes above the Tolerable Upper Intake Level (UL) also must be considered. Because the goal of planning is to achieve a desired distribution of usual intake, it is clear that to judge the success of the planning activity, assessment must occur. In most situations, planning group diets is an iterative, ongoing effort in which planners set planning goals for usual intake, assess whether the goals are achieved, and then modify their planning procedures accordingly.

GENERAL CONSIDERATIONS

Planning diets for groups is a multistep process. It involves identifying the specific nutritional goals, determining how best to achieve these goals, and, ultimately, assessing if these goals are achieved. Planning the diets of groups also involves multiple components. Planners must decide what foods to purchase, what foods and combinations of foods to offer, how the foods should be prepared, and the quantities to serve. Planners must also recognize that individuals within a group look at what foods are offered and then decide what foods to select and, finally, what foods to eat.

To address all these planning components would be an ambitious effort; many of these issues are not specifically related to using and interpreting the Dietary Reference Intakes (DRIs). This report focuses primarily on the ultimate goal of group planning as achieving a usual intake distribution with a low prevalence of inadequate or excessive intakes. In this chapter, the focus is on planning for groups that are homogeneous in terms of life stage and gender, while Chapter 4 presents an approach to planning for groups that vary in life stage and gender.

In planning diets for groups, planners often adopt broad nutritional goals and then design their programs to offer meals and diets that meet recognized nutritional standards. For example, when deciding how to plan meals for an institution like a boarding school or an assisted living facility, the objective is often to provide food with a given level of nutrients. However, it would be more appropriate to know how much of the offered food is actually consumed and what the resulting distribution of nutrient intakes is likely to be. Unless the distribution of intakes is considered, the amount being offered may not be sufficient for a substantial proportion of the residents to obtain enough of a nutrient to meet their requirements. This approach is also illustrated by some of the national food assistance programs. The objective of the Food Stamp Program, for example, is to provide low-income households with benefits so they

can purchase a low-cost, nutritionally adequate diet. However, the current goal is to offer (i.e., make available) an adequate diet, which does not necessarily translate into a low prevalence of inadequate intakes among the eligible households.

The group-feeding framework proposed in this report differs from how many planning applications are currently designed. Because this framework considers the distribution of usual nutrient intakes of the group as the basis for planning, it shifts the focus of planning away from using dietary recommendations in deciding what to offer, to what is ultimately desired in terms of the distribution of usual nutrient intake.

By focusing explicitly on the distribution of nutrient intakes of a group as the goal of group planning, the framework presented below is, in many respects, a new paradigm, and it should be tested before being implemented in large-scale group-feeding situations.

It is important to remember, however, that while planners may have desired nutrient intakes of the group as their ultimate objective, they typically can control only what is offered to individuals in the group. In this proposed framework, therefore, the link between planning and assessment is crucial. That is, since the goal of planning is to achieve a usual intake distribution with a high group prevalence of nutrient adequacy (i.e., an acceptably low group prevalence of inadequacy), then it is clear that to judge the success of the planning activity, assessment must occur.

When planning the diets of population groups, it is important to consider how usual intakes will be *distributed*, not just the mean or median intake. For some planning applications, the goal is to correctly position an intake distribution, but not to intentionally change its shape (see Figure 3-1 as an example of repositioning a distribution). In other situations it may be desirable to change the shape of the intake distribution for one or more nutrients, perhaps by targeting individuals in the tails of the distribution. This chapter first addresses group feeding where changing the shape of the distribution is not an explicit goal, and then discusses the additional challenges of planning intakes for interventions when the goal is to alter some part of the distribution. However, it is very important to keep in mind that any intervention that is designed to affect intakes of all or just some individuals in a group will more than likely result in an intake distribution that differs from the baseline distribution not only in location, but also in shape.

The framework presented in this chapter assumes that the group

is large enough so that planning and assessing do not occur at the individual level. That is, one can neither plan for specific individuals within a group nor assess the results of group planning for specific individuals in the group. In some situations, however, it may not be clear whether planners should follow procedures to plan diets for individuals or for groups. Usually the decision is driven by the information available for individuals within the group, as well as by the availability of resources to tailor diets to individual needs.

In group-feeding situations such as the National School Lunch Program, information about individuals is generally not available, and it is clear that group-planning procedures should be used. However, when the characteristics of individuals are well known to planners (e.g., a small group home for children with a variety of physical and developmental disabilities), planning may occur primarily at the individual level. Or, among groups of hospitalized patients, information about individual characteristics is potentially available, but is used only in certain cases. Planners will know whether a given individual is following a therapeutic diet (e.g., cholesterol lowering, diabetic, renal) and will also have access to additional personal information (e.g., age, sex, body size). However, for most patients on nontherapeutic diets, individual information is usually not used in planning—thus, a "hybrid" approach to planning may be adopted in which a group planning approach is used for most patients, while those on therapeutic diets may be planned for as individuals.

It is clear from the above discussion that group-feeding situations can vary considerably, and in some situations, planners may combine elements of group and individual planning. The following discussion, however, focuses only on group planning.

OVERVIEW OF PLANNING FOR NUTRIENT INTAKES OF GROUPS

Planning nutrient intakes for a group is difficult because individuals in a group, even if offered the same meal, vary in the amount and selection of foods that they eat. Planning for group feeding typically focuses on planning for institutional feeding, which includes such settings as residential schools, prisons, military garrisons, hospitals, and nursing homes. By a slight extension, this category of planning also includes many food and nutrition assistance programs such as the Food Stamp Program, child nutrition programs, and emergency food assistance programs.

The underlying principle for group planning is that the resulting distri-

bution of usual nutrient intakes will have a low prevalence of inadequate or excessive intake, as defined by the proportion of individuals in the group with usual intakes less than the Estimated Average Requirement (EAR) or greater than the Tolerable Upper Intake Level (UL).

To explain this framework it is important to review briefly the methods available for assessing the prevalence of inadequate intakes of groups. As discussed in detail in the DRI assessment report (IOM, 2000a), two related methods can be used to estimate the prevalence of inadequate intakes in a group:

1. *Probability approach.* The probability approach involves determining the probability of inadequacy for each usual intake level in the population and then averaging the individual probabilities of inadequacy across the group to obtain an estimate of the group prevalence of inadequacy. This method of dietary assessment depends on two key assumptions: intakes and requirements are independent, and the distribution of requirements is known.
2. *EAR cut-point method.* Under certain conditions, the prevalence of inadequate intakes for a group can be estimated as the proportion of the group with usual intakes less than the EAR. The EAR cut-point method is an approximation of the probability approach and can be used in most situations provided the following assumptions are met: (1) intakes and requirements are independent, (2) the requirement distribution is symmetrical around the EAR, and (3) the variance in intakes is larger than the variance in requirements.

Concept of a Target Usual Nutrient Intake Distribution

Suppose a planner is interested in planning a group diet with a high probability of nutrient adequacy (e.g., such that the prevalence of inadequacy in the group is no more than 2 to 3 percent). Given this targeted prevalence, and assuming that the EAR cut-point method can be used in assessment, the usual intake distribution of the group should be positioned such that only 2 to 3 percent of individuals in the group have usual intakes less than the EAR (see Figure 3-1, Panel B, as an example). To achieve this goal of a low prevalence of nutrient inadequacy, it may be necessary to modify the baseline usual nutrient intake distribution. The change may be as simple as a shift (up or down) of the entire baseline distribution or it may include changes in both the location and the shape of the distribution. In either case, the appropriate changes to the baseline

usual nutrient intake distribution are intended to result in the desired distribution of usual intakes. This desired distribution is referred to as the target usual nutrient intake distribution.

The simplest approach to determining the target usual nutrient intake distribution is to shift the baseline distribution, with the assumption that there will be no change in its shape. This is illustrated in Figure 3-1 for a hypothetical nutrient. Panel A shows the baseline usual intake distribution in which the prevalence of inadequate intakes (percentage of the group below the EAR) is about 30 percent. If the planning goal was to attain a prevalence of inadequacy of no more than 2 to 3 percent, the target usual nutrient intake distribution could be achieved by simply shifting the baseline usual intake distribution up, as shown in Panel B.

The appropriate shift (up or down) can be calculated as the additional (or decreased) amount of the nutrient that must be consumed to attain the prevalence of usual intakes below the EAR that is the planning goal. For example, the EAR for zinc for girls 9 to 13 years old is 7 mg/day. Current data from the Third National Health and Nutrition Examination Survey (NHANES III, as reported in IOM, 2001) show that about 10 percent of the girls have usual intakes below the EAR. If the goal were to plan intakes so that only 2 to 3 percent are below the EAR, intakes would have to be increased. When the intervention is designed to increase everyone's usual zinc intake, then the amount of the increase can be calculated as the difference between the current intake at the 2nd to 3rd percentile (which is 6.2 mg/day) and the desired intake at the 2nd to 3rd percentile (the EAR of 7 mg/day); the difference is thus 0.8 mg/day. That means that the distribution of usual intakes needs to shift up by 0.8 mg/day in order to have only 2 to 3 percent of the girls with intakes below the EAR.

The same goal of 97 to 98 percent adequate intakes could, in theory, be achieved by planning an intervention that is designed to increase the usual zinc intake of only those individuals who have low baseline zinc intake levels. However, in most group-planning situations it is not possible to identify who these individuals are, making this type of planning procedure difficult to implement.

The target usual nutrient intake distribution should also be examined to determine if it meets the goal of a low prevalence of potentially excessive intakes. For zinc, the UL for girls 9 to 13 years old is 23 mg/day. The 99th percentile of their current intake distribution is 15.5 mg/day, so even if the distribution is shifted up by 0.8 mg/day, the 99th percentile (16.3 mg/day) is well below the UL.

The Median of the Target Usual Nutrient Intake Distribution

The median of the target usual nutrient intake distribution is a useful summary measure. As will be discussed later in this chapter (see "Planning Menus to Achieve Target Usual Nutrient Intake Distributions"), it may be used as a tool in the menu planning process.

Assuming that the shape of the intake distribution does not change as a result of planning, the median of the target usual nutrient intake distribution is calculated as the median of the current usual intake distribution, plus (or minus) the amount that the distribution needs to shift to make it the target usual nutrient intake distribution.

Figure 3-1 illustrates this concept. In this example, the planning goal is to achieve a distribution of usual intake such that only 2 to 3

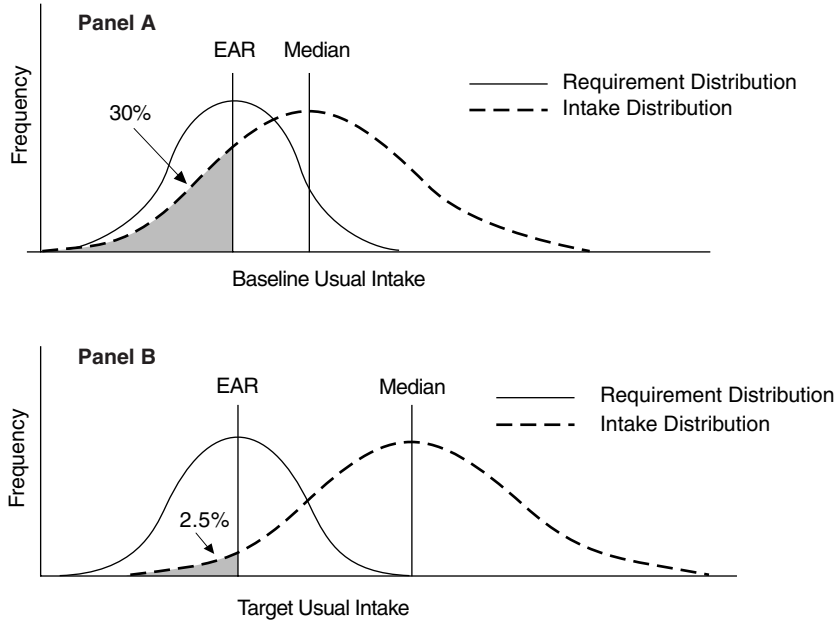

FIGURE 3-1 Concept of a target usual intake distribution. Panel A shows the baseline usual nutrient intake distribution, in which the prevalence of inadequate intake (percentage below Estimated Average Requirement) is about 30 percent. Shifting the baseline distribution up so that the prevalence of inadequate intakes reflects the planning goal (in this example, 2 to 3 percent) attains the target usual nutrient intake distribution (Panel B).

percent of the group has usual intakes below the EAR. The amount that the baseline usual nutrient intake distribution (Panel A) needs to shift so that it becomes the target usual nutrient intake distribution (Panel B) can be determined as the difference between intake at the 2nd to 3rd percentile of the baseline distribution and the EAR. This amount, added to the median of the baseline distribution, defines the median of the target intake distribution. (Under the assumption of normality of the usual intake distribution, the median of the target usual nutrient intake distribution can be calculated directly as the EAR + 2 standard deviations [SD] of intake.) Assuming that the shape of the intake distribution does not change when it is shifted, only 2 to 3 percent of the individuals in the group will have usual intakes less than the EAR when the target distribution is positioned in this manner.

How does the median of the target usual nutrient intake distribution compare with the Recommended Dietary Allowance (RDA)?

The relationship between the median of the target usual nutrient intake distribution and the RDA depends on the selected prevalence of inadequacy. With a prevalence of inadequacy of 2 to 3 percent, the target median intake usually exceeds the RDA.

In the zinc example used above for girls 9 to 13 years of age, the distribution needs to be shifted by an additional 0.8 mg/day. The median of the current zinc distribution for these girls is 9.4 mg/day, so the median of the target usual nutrient intake distribution would be 9.4 + 0.8 = 10.2 mg/day.

The median of a target usual nutrient intake distribution exceeds the RDA because the variance in usual intakes typically exceeds the variance of the requirement. Recall that in the case of a normal distribution of requirements, the RDA equals the EAR + 2 SDs of the *requirement*. However, the target usual nutrient intake distribution (and therefore, its median) is determined based on the variability of *intakes*. In the zinc example, the RDA for girls is 8 mg/day, but the target median intake is 10.2 mg/day. Thus, selection of the RDA levels as the median of the target usual intake distribution is not recommended as it results in a percentage of inadequacy greater than would likely be selected with more careful consideration.

In positioning the distribution of usual intakes relative to the EAR, the same three assumptions delineated earlier as being required to use the EAR cut-point method in the dietary assessment of groups must be satisfied (IOM, 2000a). Later in this chapter, methods are

described for estimating the target usual nutrient intake distribution when these assumptions are not valid.

CONSIDERATIONS IN PLANNING FOR A TARGET USUAL NUTRIENT INTAKE DISTRIBUTION

Planning for a target usual nutrient intake distribution involves several considerations, which form the basis of the following discussion. These include:

- estimating the existing or baseline distribution of usual nutrient intake;
- selecting the target prevalence of inadequacy;
- estimating the target usual nutrient intake distribution;
- assessing the feasibility of obtaining the target usual nutrient intake distribution; and
- planning for groups when assumptions of the Estimated Average Requirement cut-point method are violated.

Estimating the Existing or Baseline Distribution of Usual Nutrient Intake

Estimating the target usual nutrient intake distribution requires information about the shape of the existing distribution of usual nutrient intakes. Specifically, the distribution of usual intakes is needed, with the effect of day-to-day variation removed. The between-person variance in usual intakes is typically less than the variance of the observed distribution of intakes in a group, because the latter includes both within-person (day-to-day) variation and between-person (individual-to-individual) variation. Thus, the observed intake distribution must be adjusted to approximate the distribution of true usual intakes in the group.

To estimate the distribution of usual intakes directly for the group of interest, the actual intakes of a representative sample of the group must be assessed over at least two nonconsecutive days or three consecutive days and an adjustment procedure applied (IOM, 2000a). Food frequency questionnaires are not recommended for use in assessments of usual nutrient intakes because of concerns about the accuracy of nutrient intake estimates derived from this approach (see the Dietary Reference Intakes assessment report [IOM, 2000a] for a full discussion of this issue). Rather, intakes should be assessed through the use of 24-hour dietary intake recalls or diet records.

Procedures to adjust observed intake distributions to remove the effect of within-person variation have been developed (IOM, 2000a; NRC, 1986; Nusser et al., 1996). It should be noted, however, that the most appropriate adjustment method depends in part on the size of the group, with the Iowa State University method (Nusser et al., 1996) recommended for large groups, but the National Research Council (NRC, 1986) method perhaps offering advantages in the adjustment of intake distributions for small samples (defined here as groups smaller than 40 to 50 people). A discussion of these methods is presented in Appendix E. Using the adjusted distribution, planners can identify the percentiles of intake that describe the distribution of usual intakes.

In many group-planning activities, a baseline or current usual nutrient intake for the group being planned for may not be available. In these situations it may be possible to approximate the percentiles of usual intake for the target group from existing data on usual intakes for a group with similar characteristics. Distributions of usual nutrient intake derived from general population surveys are presented in appendixes to the DRI reports (IOM, 1997, 1998a, 2000b, 2001, 2002a), and these percentiles of intake may be appropriate for use in some planning activities. Where such secondary sources are used, however, planners must be careful to consider factors in the target group that contribute to between-person variation in usual intakes and verify that the same types of factors are present in the group from which the distribution of usual intakes is inferred. For example, if one were planning diets for a group of elderly residents in a long-term care facility, it would probably not be appropriate to estimate the distribution of usual intakes from data on a free-living elderly group. The latter group would likely display greater heterogeneity in intakes and thus larger between-person variation in usual intakes than the institutionalized group.

When estimating the distribution of usual intakes, whether from primary or secondary sources, the planner should keep in mind possible sources of error associated with self-reported intakes. Despite corrections to remove the effect of within-person variation, additional random error occurs as a result of errors in dietary assessment methodology, sampling variability, and inaccuracies in nutrient databases. In addition, the underestimation of actual energy intakes is well documented (Johansson et al., 1998; Mertz et al., 1991), and related nutrients may be systematically underestimated as well. Although there is currently no acceptable method to correct for this underestimation, the planner should be aware that such an underestimation of intake could lead to an overestimation

of the prevalence of inadequate nutrient intakes, and thus of the actual need for increased intakes to reduce nutrient inadequacy. While the planner is encouraged to plan for adequate nutrients consumed, rather than just adequate nutrients offered or served, the accurate assessment of and subsequent planning for diets as consumed is challenging.

Selecting the Target Prevalence of Inadequacy

In planning diets for groups, the target prevalence of inadequacy is ultimately a matter of judgment. A conservative approach is to aim for a prevalence of 2 to 3 percent. In this case, the likelihood that a randomly selected individual in the group has an inadequate intake would be between 2 and 3 percent, representing a probability of between 0.02 and 0.03. A higher prevalence could be selected, though, and the selected prevalence of inadequacy could vary by nutrient, depending upon available resources.

In setting planning goals for groups, two scenarios are particularly interesting to consider. The first is planning so that the resulting distribution of usual intakes has *all* individuals in the group consuming at least the Recommended Dietary Allowance (RDA), a goal that might appear to be consistent with what practitioners often counsel clients to achieve with their individual diets (Figure 3-2, Panel B). The second is planning such that the median of the target distribution of usual intakes in the group equals the RDA (Figure 3-2, Panel C). This goal appears consistent with current planning applications where individuals in a group are offered foods and meals that provide 100 percent of the RDA. Presumably, this goal reflects the notion that if individuals consume, on average, what is offered, that mean intake will equal the RDA. As shown below, neither of these two scenarios is being proposed or promoted for group planning because each has potentially negative implications.

To examine the implications of these two scenarios, Figure 3-2 compares the target usual nutrient intake distribution for a hypothetical nutrient with an EAR of 50 units, a standard deviation (SD) of requirement of 7.5 units (coefficient of variation [CV] of requirement = 15 percent), and an RDA of 65 units. The intake distribution will simplistically be assumed to be normal, with a standard deviation of usual intake of 18 units. Panel A, with a group prevalence of inadequacy of 2 to 3 percent, is similar to the target usual nutrient intake distribution portrayed in Figure 3-1, while Panels B and C show the two scenarios described above. Several important conclusions are clear from Figure 3-2:

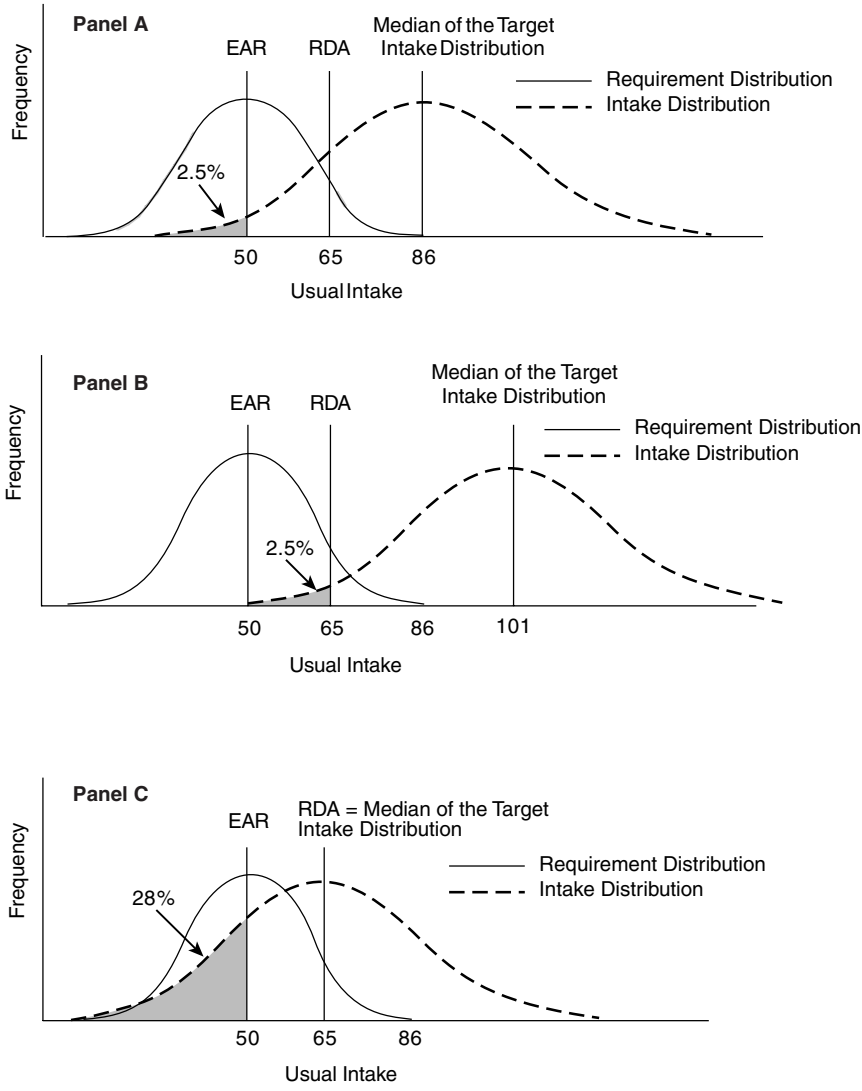

FIGURE 3-2 Panel A: low group prevalence of inadequacy: 2.5 percent of the population has usual intake below the estimated average requirement. Intake distributions are assumed to be normal. Median of the target intake distribution = Estimated Average Requirement (EAR) + 2 Standard Deviations (SD) of *intake* (in this example, the SD of intake = 18 units). Panel B: low individual risk of inadequacy: 2.5 percent of the population has usual intake below the Recommended Dietary Allowance (RDA). Intake distributions are assumed to be normal. Median of the target intake distribution = RDA + 2 SD of *intake* (in this example, SD of intake = 18

• Panel A: planning for a low group prevalence of inadequacy. Around 2 to 3 percent of the group has a usual intake less than the EAR. Approximately 16 percent of the group will have a usual intake less than the RDA for this nutrient with an EAR of 50 units, an SD of requirement of 7.5 units, and an SD of usual intake distribution of 18 units. Note that the median of this target intake distribution is 86 units, considerably higher than the RDA of 65 units.

• Panel B: planning for a low individual risk of inadequacy. Around 2 to 3 percent of individuals have a usual intake less than the RDA. The target usual intake distribution is positioned substantially higher when planning for a risk of inadequacy of no more than 2 to 3 percent for each individual, as opposed to a prevalence of inadequacy of 2 to 3 percent for a group. Only an extremely small proportion of the group is likely to have a usual intake less than the EAR and, thus, the prevalence of inadequacy is essentially zero. Although not shown in the figure, concerns about some individuals exceeding the Tolerable Upper Intake Level may arise when setting a target usual nutrient intake distribution so high.

• Panel C: planning for a target usual nutrient intake with a median equal to the RDA. The target usual nutrient intake distribution (and its median) is substantially lower than for either a low group prevalence of inadequacy or low risk for each individual. Fifty percent of the group will have a usual intake less than the RDA. The prevalence of inadequacy is high. In this example, the proportion of the group with a usual intake less than the EAR is about 28 percent.

The implications of Panel C are extremely important and deserve to be highlighted. When the target usual nutrient intake distribution is positioned to have a median equal to the RDA, the expected prevalence of inadequate intake is fairly high, around 28 percent in this example. The reason for this apparent inconsistency is the variance in usual intake that is observed in most groups. The proportion of the group with inadequate intake when the target usual intake distribution has a median at the RDA is directly proportional to the standard deviation of usual intake. At the extreme, if there were no variance in intake and all individuals in the group con-

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units). Panel C: higher group and individual risk of inadequacy: target median intake equals the RDA. Intake distributions are assumed to be normal. Median of the target intake distribution = RDA (65 units in this example). EAR = 50 units in this example, with a standard deviation of 7.5 units) and RDA = EAR + 2 SD of *requirement*, or 65 units.

sumed exactly what was offered (100 percent of the RDA), then the prevalence of inadequate intake would be 2 to 3 percent. As a less extreme example, if the standard deviation of usual intake were 9 units rather than the 18 units used above, then the prevalence of inadequacy would be about 15 percent instead of the 28 percent estimated above.

Ultimately planners must decide what is the acceptable prevalence of inadequacy. If planners decide that either a low group prevalence (Panel A) or a low individual risk (Panel B) of inadequacy is the underlying goal, then meals, food plans, and food assistance benefits for groups must offer substantially more than the RDA for the resulting distribution of usual intake to achieve this goal. On the other hand, planners might decide that a target usual nutrient intake distribution with a median intake equal to the RDA is the planning goal (Panel C), assuming that if everyone consumed all that was offered, then the diet would be nutritionally adequate for almost all individuals in the group. However, this is usually not a realistic assumption, and thus the inevitable variation in usual intakes will result in a prevalence of inadequacy that is greater than 2 to 3 percent.

Estimating the Target Usual Nutrient Intake Distribution

As indicated in the previous section, a planner must first determine the acceptable group prevalence of inadequate intakes, whether it is 2 to 3 percent, 28 percent, or any other selected prevalence. Recall that under certain assumptions, the group prevalence of inadequate intakes is simply the proportion of the group with usual intakes less than the EAR. Planning in this case involves positioning the usual intake distribution such that the acceptable group prevalence of inadequate intakes is set at the EAR. This goal is often achieved by examining an existing usual intake distribution and estimating how it would need to change.

Estimating the Target Usual Nutrient Intake Distribution Assuming a Normal Distribution of Usual Intake

To determine the target usual nutrient intake distribution with the selected prevalence of inadequacy, it is useful to examine the admittedly simple example of a normal distribution of usual intake. When it is known that the usual intake distribution approximates normality, as depicted in Figure 3-2, the position of the target usual nutrient intake distribution can be estimated very simply with a table

of selected areas under the normal distribution. The median of the target usual intake distribution is the EAR + $Z \times SD_{usual\ intake}$ where Z comes from a table of areas under the curve of a normal distribution. Table 3-1 reproduces part of a table of Z values. For example, as shown in Panel A of Figure 3-2, when the EAR is 50 units and the $SD_{usual\ intake}$ is 18 units, a 2.5 percent prevalence of inadequacy (Z = 1.96 at 2.5 percent) would be expected when the median intake was 86 units (86 = 50 + [1.96 × 18]).

Estimating the Target Usual Nutrient Intake Distribution Assuming a Non-Normal Distribution of Usual Intake

In most cases, however, the distribution of usual nutrient intakes is not normally distributed, so the $SD_{usual\ intake}$ cannot be used to identify the position of the target usual nutrient intake distribution. The approach to estimating the target distribution for a non-normal usual intake distribution is similar in principle to the approach described above, although it does not depend on the SD of intakes and a Z value. That is, one first specifies the acceptable prevalence of inadequate intake (such as 2 to 3 percent), and then plans to

TABLE 3-1 Setting the Target Median Intake[a] for Nutrients with Intake Distributions Approximating Normality: Selecting Z Values

Acceptable Group Risk of Inadequate Intakes (%)	Z Value: Multiplier for the Standard Deviation of Intake
0.05	3.27
0.5	2.57
1.0	2.33
1.5	2.17
2.0	2.05
2.5	1.96
3.0	1.88
5.0	1.65
10.0	1.28
15.0	1.03
25.0	0.68
50.0	0.00

[a] Target median intake = EAR + $Z \times SD_{usual\ intake}$, where EAR = Estimated Average Requirement, Z = statistical tool to determine areas under the normal distribution, SD = standard deviation.
SOURCE: Adapted from Steel et al. (1997).

position the usual intake distribution such that the percentile of usual intake associated with this specified prevalence of inadequate intake equals the EAR.

Consider the zinc example presented previously for girls 9 to 13 years of age. Table 3-2 presents descriptive data on the usual intake of zinc for these girls based on data from the Third National Health and Nutrition Examination Survey (NHANES III) as adjusted (IOM, 2001). Recall that the EAR for zinc for girls 9 to 13 years of age is 7 mg, which is approximately equal to the 10th percentile of usual intake. If the planning goal is to have 2 to 3 percent of individuals in a group have usual intake less than the EAR, the distribution of usual intake should be shifted such that the 2nd to 3rd percentile corresponds to 7 mg. That shift is about 0.8 mg, so the target usual nutrient intake distribution would have a median of about 9.4 + 0.8 = 10.2 mg (where 9.4 is the observed median zinc intake for this group), if it is assumed that the shape of the distribution does not change with whatever intervention is required to increase intakes by 0.8 mg.

Note the substantial error that would occur if the distribution of usual intake were assumed to be normal and the median of the target distribution were estimated to be the EAR + 2 × $SD_{usual\ intake}$. In this case, the $SD_{usual\ intake}$ is 3.1 mg and the median of the target distribution would be estimated as 7.0 + (2 × 3.1) = 13.2 mg, which is more than the value of 10.2 mg, as estimated from the non-normal distribution of usual intake.

TABLE 3-2 Distribution of Usual Intake of Zinc, Girls 9 to 13 Years of Age

Percentile of Intake	Zinc Intake (mg)
1st	6.0
2nd	6.1
3rd	6.3
5th	6.5
10th	7.1
25th	8.1
50th	9.4
95th	13.5
99th	15.5

NOTE: Mean intake = 9.6 mg, median intake = 9.4 mg.
SOURCE: Adapted from IOM (2001).

Assuming Stability in the Distribution of Usual Intakes

The methods proposed here for defining the target distribution of usual nutrient intakes for a group all depend on knowledge of the distribution of requirements for the group and an estimate of the shape of the usual nutrient intake distribution within the group. Implicit in these methods is the assumption that the shape of the distribution of usual nutrient intakes is a stable characteristic of the group, and that irrespective of where the desired distribution of usual intakes is positioned, this shape remains unchanged. If intake is normally distributed, this assumption means that the SD of intake remains unchanged. At higher or lower levels of intake, however, it seems likely that the shape of the distribution and the magnitude of the variance in usual intakes may change. Further research is required to determine the nature of such changes.

Precision of the Estimated Prevalence of Inadequate Intakes

An assumption that is fundamental to both dietary planning and dietary assessment is that the EAR cut-point method accurately reflects the group prevalence of nutrient inadequacy. Because the acceptable prevalence of inadequacy is almost always a low number, planners should be aware of the approximate nature of the prevalence estimate. As described elsewhere (IOM, 2000a), the EAR cut-point method appears to be robust in most situations and is therefore a recommended approach. However, the degree of relative error increases when the prevalence of inadequacy is low. Error also arises as a function of the sample size upon which the assessment is based. For example, an estimated prevalence of inadequacy of 3 percent, based on a sample size of 100, could imply a true population prevalence between 0 and 6 percent (95 percent confidence interval). Thus, in practical situations, if one planned for a prevalence of inadequacy of 2 to 3 percent, implemented the plan, assessed the results and found that the prevalence of inadequacy was 5 percent, this should be interpreted as consistent with the planning goal.

Feasibility of Obtaining the Target Usual Nutrient Intake Distribution

The principle underlying the framework for planning for group feeding is that information on the nutrient requirements and usual intakes can be used to develop a plan where intakes will meet the requirements of all but a targeted proportion of the group. In esti-

mating the target usual intake distribution, each nutrient must be considered individually. However, planning diets for groups necessarily requires the development of food plans or menus that will achieve planning goals for the full range of nutrients considered, while at the same time meeting individuals' energy needs. In planning for group feeding, an important question to ask is whether a target usual nutrient intake distribution is attainable (i.e., are adequate resources available).

Recall that the target intake distribution depends on the median nutrient requirement (EAR) and the estimated distribution of usual intakes in the group. If all individuals in a group consume exactly what they are offered in a group-feeding situation, then the SD of intake would be zero and the amount offered would equal the planners' nutrient intake goal. Yet individuals in a group seldom consume exactly what is offered. Some individuals in a group will eat less than what is offered, and in some situations, others may be able to supplement what is offered with foods from other sources.

In general, the feasibility of attaining the target usual nutrient intake distribution depends in part on the variance in usual intakes in the group. Achieving intake targets is easiest in group-feeding situations where the variability in usual intakes is relatively small and relatively stable. In group-feeding situations, such as nursing homes or other long-term care facilities where staff have a good knowledge of food consumption patterns and are able to tailor menu options to meet the preferences of most individuals in the group, target usual nutrient intake distributions may be readily attainable.

Planners may also be able to manipulate the variance in usual intakes to some extent through the design of menus. For example, it may be that offering pizza in a school lunch has an SD of intake considerably smaller than the SD of intake for a less desirable entree. In the former situation, it would obviously be easier to achieve the target usual intake distribution than in the latter, at least for the nutrients provided by pizza.

However, under some circumstances, resource constraints may mean that it is simply not feasible to design diets or meal plans to achieve the target usual intake distribution for a particular nutrient based on a targeted prevalence of inadequacy. In these situations, one alternative may be to consider whether a higher prevalence of inadequacy would be acceptable. Another alternative is to consider program interventions that will attempt to change the shape of the distribution, for example, by targeting the lower tail of the distribution, as discussed later in this chapter. A key advantage of the frame-

work developed here is that it allows planners to estimate the prevalence of inadequacy in advance, thus guiding an evaluation of the feasibility of attaining any selected prevalence level.

Planning for Groups When Assumptions of the EAR Cut-Point Method Are Violated

In the methods presented thus far, the target usual nutrient intake distribution has been set in relation to the EAR as a means to achieve intakes with an acceptably low prevalence of inadequacy. This approach to planning for groups is only appropriate under certain assumptions. These assumptions are:

- the requirement distribution is symmetric;
- the variance of requirements is less than the variance of usual intake; and
- the usual intake of, and requirement for, a nutrient are not correlated.

Alternative approaches to group planning must be employed when any of these assumptions are not met. In most cases, the alternative is based on using the probability approach (NRC, 1986) when planning for group feeding.

What Happens When the Requirement Distribution Is Not Symmetric?

When the distribution of requirements is not symmetric about the median requirement, but instead is positively skewed (e.g., skewed to the right as occurs for iron), the EAR cut-point method *underestimates* the true prevalence of inadequacy in a group (IOM, 2000a). If the requirement is negatively skewed (e.g., skewed to the left), the method *overestimates* the true prevalence. Thus, if planning for normal group feeding involves a nutrient where the requirement distribution is not symmetric, positioning the target usual nutrient intake distribution as a function of the EAR will not achieve the targeted risk of inadequacy. Although little empirical evidence is available on the distribution of requirements for most nutrients, it is often implicitly assumed that the distribution is symmetric around the median requirement.

One nutrient for which it is known that the requirement distribution is not symmetric is iron (IOM, 2001). *Thus, the probability approach should be used in planning iron intake for groups.*

When the distribution of requirements is skewed, the same principles for normal group feeding apply but the underlying approach used in planning differs. That is, the planning objective remains the same—to position the usual intake distribution such that a specified proportion of the group has a usual intake less than the requirement. Instead of using the EAR cut-point method to define that target usual intake distribution, however, the probability approach can be used. In this case, the first step is to estimate the distribution of usual intakes in the group. The probability approach (NRC, 1986) is then applied to the adjusted distribution of intakes to estimate the prevalence of inadequacy in the group. To determine what level of change in intakes would be required to achieve an acceptably low risk of inadequacy, the distribution of usual intakes is repositioned by adding a constant to each point along the distribution, and the prevalence of inadequacy recalculated. This procedure is repeated, with the estimated usual intake distribution being shifted in increments and the prevalence of inadequacy recalculated until an acceptably low risk of inadequacy is achieved.

For example, use of the probability approach to assess the iron intake of women aged 31 to 50 in the NHANES III survey suggested that 15 to 20 percent of women had inadequate intakes (IOM, 2001). In that survey, median iron intake from food was 12.1 mg/day, and the 5th and 95th percentiles were 7.4 mg/day and 20.3 mg/day, respectively. If the planning goal was to reduce the prevalence of inadequacy to less than 5 percent, iron intake would need to increase. The initial choice of the constant to add to each point in the distribution is arbitrary. In this case, one might begin by adding 1 or 2 mg, and then use the probability approach to estimate the resulting prevalence of inadequacy. If the prevalence was still above the planning goal, additional amounts would be added until assessment using the probability approach indicated that the planning goal had been met.

What Happens When the Variance of Requirements Exceeds the Variance of Usual Intakes?

When the variance of the requirement distribution exceeds the variance in usual intakes in the group, the EAR cut-point method usually results in a biased estimate of the group prevalence of inadequacy. As a result, there will be a bias in estimating the target usual intake distribution that would achieve the targeted prevalence of inadequacy. In this case, the probability approach described above should be used for group planning.

For nutrients for which average requirements have been estimated, the CVs have been assumed to be 10 to 20 percent. Among free-living populations, the between-person variation in usual intakes typically is considerably higher than this, but in institutional settings where residents are fed similar diets (e.g., prison inmates or residents of a long-term care facility), the distribution of usual intakes *may* display less variance than the distribution of individual requirements for a particular nutrient. When this is confirmed or strongly suspected, the probability approach is the preferred method to define the target usual nutrient intake distribution.

What Happens if Usual Intake and Requirement Are Correlated?

Usual intakes for certain nutrients (e.g., energy) increase with higher needs. This results in a situation in which individuals with higher requirements have higher usual intakes, that is, the intake and the requirement for a given individual are correlated rather than independent.

In general, when intake and requirement are correlated, both the EAR cut-point method and the probability approach would overestimate the prevalence of inadequate intake. Thus, the approach presented above of planning for a usual intake distribution when intake and requirement are correlated will overestimate the usual nutrient intake distribution necessary to achieve planning goals.

Can the target usual nutrient intake distribution for food energy be estimated based on either the EAR cut-point method or the probability approach?

No. Empirical evidence suggests a high correlation between usual energy intake and energy expenditure to maintain current body weight. This correlation most likely reflects either the regulation of energy intake to meet needs or the adjustment of energy expenditures to be consistent with usual intake (FAO/WHO/UNU, 1985). Because of this correlation, neither the EAR cut-point method nor the probability approach can be used to assess the proportion of a group with inadequate energy intake and, thus, cannot be used in planning for adequate energy intakes.

What is the expected bias resulting from the correlation between intake and requirement? At correlation levels no larger than 0.25 to 0.30, the bias is likely to be low (see IOM [2000a] for an in-depth discussion). For higher levels of correlation, especially as the correlation between usual intake and requirement approaches 1.0,

neither the EAR cut-point method nor the probability approach can be applied to define a target usual intake distribution for group planning.

PLANNING FOR ENERGY AND MACRONUTRIENT INTAKES OF GROUPS

As is true for individuals, the underlying objective of planning for energy intakes of a group is similar to planning for nutrients—to attain an acceptably low prevalence of inadequacy and of potential excess. It should be emphasized that in the context of planning energy intakes for groups, energy requirements are operationally defined as the total energy expenditure required to maintain a group member's current weight and activity level, regardless of whether that weight is desirable. Thus, planned intake represents the amount of energy required to maintain current status, so in this context, "energy requirement" and "total energy expenditure" are used interchangeably.

The approach to planning for energy differs substantially from planning for other nutrients. There are a number of reasons why this is true. For example, because of the serious and pervasive problem of underreporting of energy intakes, estimating the distribution of energy intakes may lead to erroneous conclusions. Second, there is a high correlation of energy intake and total energy expenditure such that neither the probability approach nor the Estimated Average Requirement (EAR) cut-point method can be used. In addition, and of greatest importance, there are adverse effects associated with consuming amounts *above* or *below* the requirement. Thus, instead of determining usual energy intakes to use as a basis for planning, energy expenditure can be estimated based on gender, height, weight, age, and activity levels. By definition, energy expenditure is equal to intake when energy balance exists. Two approaches to meeting this objective could be considered: estimate requirements for the reference person used to establish the Dietary Reference Intakes (DRIs), or obtain an average of estimated requirements for group members.

Estimate Requirements for the Reference Person

At first glance, it might appear reasonable to estimate group energy needs based on the estimated energy requirement (EER) for the reference person used to represent the group when describing the DRIs. For example, if one were planning for a group of low-active

men aged 19 to 30, one could estimate the EER for the reference man who was 70 kg in weight and 1.76 m in height who performed a low level of activity, and use this number (about 2,700 kcal) as the target intake for the group. This approach, however, requires that the reference individual represents group average values for age, height, weight, and activity level. For most life stage and gender groups, the reference person weighs less than the average person (e.g., the reference 19- to 30-year-old man weighs 70 kg; the average weight in this age range is 76 kg). Thus, estimating group energy needs based on the reference individual would underestimate group requirements, and the distribution of intakes would not correspond to the distribution of requirements.

Obtain an Average of Estimated Requirements for Group Members

The recommended approach would be to attempt to plan for an average energy intake equal to the average energy expenditure of the group. For example, if one were planning for the energy intake of a group of men aged 19 to 30, one could estimate the energy expenditure for each individual in the group (assuming one had access to data on height, weight, age, and activity level) and then use the average of these values as the average group-planning goal.

Table 3-3 shows an example of how this could be done for a small group of six healthy men. In this hypothetical example, it can be

TABLE 3-3 Example of Estimating an Average Energy Requirement for a Group of Men Aged 19 to 30

Subject	Age (y)	Height (m)	Weight (kg)	Physical Activity Level (physical activity coefficient)	Estimated Energy Requirement[a]
1	21	1.83	95	Sedentary (1.0)	2,961
2	27	1.77	75	Low active (1.11)	2,789
3	25	1.69	60	Active (1.25)	2,757
4	19	1.80	75	Low active (1.12)	2,883
5	30	1.73	80	Very active (1.48)	3,641
6	25	1.75	75	Low active (1.11)	2,796
Total					17,827
Mean					2,971

[a] Energy (kcal) = 661.8 – (9.53 × age [y]) + physical activity coefficient × (15.91 × weight [kg] + 539.6 × height [m]).
SOURCE: IOM (2002).

seen that the average expenditure of the group is 2,971 kcal/day. If 2,971 is used as the average planned intake for this group, it exceeds the estimated requirement of five of the men, and is below the estimated requirement of one large, very active man (in a larger, more homogeneous group, one would expect the estimate to be inadequate for half the men and above the requirement for the other half). However, because intakes and requirements are highly correlated, and assuming that all members of the group have access to food, most members of the group will consume an amount of energy equal to their expenditure. Thus, planning for a mean group intake that approximates the mean estimated requirement should allow a distribution of intakes that corresponds to the distribution of actual requirements.

As with other planning applications, assessing the plan for energy intakes of a group following its implementation would lead to further refinements. In the case of energy, however, assessment would be based on monitoring body weight rather than on reported energy intake (IOM, 2002a).

Planning the Macronutrient Distribution

In addition to planning for a group's mean energy intake, another goal could be to plan for a macronutrient distribution in which the percentages of energy intake of most group members fall within the Acceptable Macronutrient Distribution Ranges that have been recommended for individuals. These ranges exist for total carbohydrate, total fat, *n*-6 polyunsaturated fatty acids, *n*-3 polyunsaturated fatty acids, and protein. For adults, the suggested ranges are 45 to 65 percent, 20 to 35 percent, 5 to 10 percent, 0.6 to 1.2 percent, and 10 to 35 percent of energy, respectively (IOM, 2002a).

As an example, consider the distribution of usual intake of energy from protein, carbohydrate, and total fat in women aged 31 to 50 years, shown in Table 3-4, and assume that the planning goal is to have no more than 5 percent below the lower end and no more than 5 percent above the upper end of the acceptable range. For protein, the prevalence of usual intakes both below and above the acceptable range is essentially zero, so one might plan to maintain the current usual intake distribution with a median intake of 15.6 percent of energy.

For carbohydrate, however, approximately 20 percent of women have usual intakes below 45 percent of energy, the lower end of the range. If one uses the approach outlined above to plan for nutri-

TABLE 3-4 Selected Percentiles for Usual Daily Percentage of Total Energy from Protein, Carbohydrate, and Fat for Women Aged 31 to 50 Years, Continuing Survey of Food Intakes by Individuals, 1994–1996, 1998

	AMDR[a] (%)	Percentile								
		1st	5th	10th	25th	50th	75th	90th	95th	99th
Protein	10–35	10.3	11.8	12.5	13.9	15.6	17.4	19.2	20.4	22.7
Carbohydrate	45–65	35.2	40.1	42.6	46.8	51.3	56.0	60.4	63.2	68.9
Fat	20–35	20.2	23.9	25.9	29.3	32.8	36.4	39.6	41.6	45.2

[a] AMDR = Acceptable Macronutrient Distribution Range.
NOTE: Estimates are based on two daily intakes for each respondent in the sample. The Iowa State University (ISU) method was used to estimate individual usual intakes of energy from protein, carbohydrate, fat, and total energy. One gram of protein was assumed to provide 4 kcal of energy, 1 g of carbohydrate was assumed to provide 4 kcal of energy, and 1 g of fat was assumed to provide 9 kcal of energy. A modification of the ISU method was then implemented to estimate the distribution of the nutrient density (Goyeneche et al., 1997).
DATA SOURCE: ARS (1998).
SOURCE: ENVIRON International Corporation and Iowa State University Department of Statistics, as reported in IOM (2002a).

ents and begins by planning to reduce the prevalence of low carbohydrate intakes to 5 percent, one would shift the distribution so that the 5th percentile of intake was 45 percent, or an increase of about 5 percentage points from the observed distribution. The median of that distribution would be 56.3 percent of energy from carbohydrate, compared to the observed 51.3 percent. However, assuming that the shape of the distribution did not change, intake at the 90th percentile would increase to 65.4 percent, such that 10 percent would have carbohydrate intakes above the upper end of the range, rather than the desired 5 percent.

In contrast, for fat the prevalence of intakes below 20 percent of calories is essentially zero (< 1 percent), but over 25 percent of women have usual intakes above the upper end of the range (> 35 percent). To decrease this to 5 percent, one would plan to position the usual intake distribution such that intake at the 95th percentile was 35 percent rather than the observed 42 percent, a decrease of 7 percentage points. The median of that distribution would be 25.8 percent of energy from fat (32.8 – 7 = 25.8). However, assuming the shape

of the distribution did not change, the resulting intake distribution would be such that more than 10 percent of women would have intakes below the lower end of the range (23.9 – 7 = 16.9).

One approach to minimizing the proportions of a group that fall below or exceed the acceptable ranges would be to first plan for a low prevalence of inadequate protein intakes (i.e., a low proportion with intakes below the EAR). Because adult women appear to have a low prevalence of inadequacy for total protein, protein intakes could be maintained at the current 15.6 percent of energy, leaving the remaining 84.4 percent of energy to be allocated between fat and carbohydrate. Starting with fat, one might plan for a median intake at the midpoint of the acceptable range, or in this case, about 28 percent of energy. Because macronutrient intakes expressed as a percentage of energy appear to have reasonably symmetrical usual intake distributions (IOM, 2002a), planning for the midpoint would balance the proportions below and above the acceptable range. Finally, the planned median intake of carbohydrate would be determined by difference. In this example, planning for a median intake of 15.6 percent of energy from protein and 28 percent of energy from fat would leave the remaining 56.4 percent to come from carbohydrate. This example does not consider the possible contribution of energy from alcohol. If alcohol is consumed, its energetic contribution should be counted as part of the fat intake (IOM, 2002a). For example, if alcohol contributed 3 percent to energy intake, this amount would be subtracted from the Acceptable Macronutrient Distribution Range for fat, leaving 17 to 32 percent of energy from fat.

The above approach to planning ranges of macronutrient intake, however, might still lead to a situation in which undesirably high proportions of the group have fat or carbohydrate intakes below or above the acceptable range. Accordingly, planners may need to plan an intervention that would change the *shape* of the macronutrient distributions, perhaps focusing on reducing the proportions above the upper boundary of the range for total fat and below the lower boundary of the range for carbohydrate.

PLANNING MENUS TO ACHIEVE TARGET USUAL NUTRIENT INTAKE DISTRIBUTIONS

After the planner has estimated a target usual nutrient intake distribution for each nutrient of interest, this information then needs to be incorporated into a plan of how to feed a group such that the target usual nutrient intake distribution is achieved.

Depending upon the planning context, planning how to achieve this may involve different considerations. As examples, planning may involve developing a menu for a meal to serve at an elderly nutrition center; it may involve determining which foods to offer as a school lunch or as a meal in a prison or other institution; it may mean devising an emergency food ration; or it may require developing a food plan to serve as the basis for a food assistance program or a food guide to use in planning menus for groups.

Regardless of the planning context, planning to achieve the target nutrient intake distribution ultimately involves determining what to offer or serve the individuals in a group. Yet, regardless of what is offered to a group, intakes—the ultimate goal of group planning—will differ from what is offered. Members of the group will vary in what they consume of the foods offered and in the amount of foods that they consume from other sources. Moreover, in most situations, what is offered itself varies. For example, a given menu may offer milk, which may include a choice of whole, reduced fat, skim, or chocolate.

Unfortunately, limited information is available on the link between what is offered and intake, and what information is available most certainly reflects the context in which the planning occurs. Nevertheless, after the planner has estimated a target usual intake distribution for each nutrient of interest, this information needs to be operationalized into a menu or any other instrument (such as food vouchers). Menu planning involves several steps:

1. establishing an initial goal for the nutrient content of the menu that is based on the target usual nutrient intake distribution;
2. determining what foods to offer that will most likely result in a distribution of usual nutrient intake that approximates the target, and thus attains the desired probability of nutrient adequacy; and
3. determining the quantities of foods to purchase, offer, and serve.

Each of these steps is discussed in greater detail below.

Establishing an Initial Goal for the Nutrient Content of the Menu

In a simple situation, where it was assumed that nutrient *intake* equaled the estimated nutrient content of the foods *provided*, and that only a single combination of foods is to be offered, it might appear logical to use the median of the target usual nutrient intake distribution as a goal for the nutrient content of a menu. As

described earlier, this would be projected to lead to an intake distribution with the desired prevalence of nutrient adequacy, provided that the shape of the distribution did not change. However, in most group-planning situations, nutrient intakes are less than the estimated nutrient content of the foods provided (i.e., food is not completely consumed). Furthermore, many planning applications involve offering a variety of menu options from which the members of the group will select foods. For these reasons, the planner might aim for a menu that offers a variety of meals with a nutrient content range that includes, or even exceeds, the median of the target usual nutrient intake distribution.

Determining What Foods to Offer

After all the nutrient targets have been set, the planner must select foods that will provide this average level of nutrient *intake* and divide these foods into different meals and snacks. To convert nutrient intake targets into food intakes, planners will usually rely on food guides such as the Food Guide Pyramid, published menus, and previously used menus to design a menu that is likely to result in the target level of adequacy. This will typically be an iterative process, often assisted by nutrient calculation software that allows interactive changes to menus and recalculation of the nutrient levels at each step.

Determining the Quantities of Foods to Purchase, Offer, and Serve

Designing menu *offerings* to meet an *intake* target is a difficult task. Because food selections and food waste vary among groups, and among menus within groups, the appropriate procedures for determining the foods to purchase and offer depend heavily on the particular planning context. Few data are available on the relationship between offerings and intakes, and it is therefore difficult to offer the planner a concrete goal in terms of menu planning when the targets have been determined in terms of nutrient usual intakes. In an attempt to offer practical guidance to planners, several still-to-be-tested assertions may be of use:

- Offering meals with an average nutrient content equal to the median of the target usual nutrient intake distribution is likely to result in lower than planned-for adequacy of intakes. This is because individuals in a group tend to consume less than what is offered to them.
- The relationship between offerings and intakes is likely to be

dependent on context. For example, in planning situations in which individuals' choices are constrained to the offered meal (as in an assisted living facility, perhaps), the intake goals might be easier to achieve than in those cases where individuals get to choose foods from a wide range of options that provide varying levels of specific nutrients (such as in a school cafeteria).

- The shape of the intake distribution is likely to change as menus offered to groups change. Thus, even if the menu offered is designed to achieve the target intake distribution and associated level of nutrient adequacy, it is very important to evaluate the impact of the new menu on intakes, as discussed later in this chapter.

The discussion above clearly highlights the need for more research in this area. As stated, planners must be able to translate the nutrient intake goals into menu offerings, and the knowledge necessary to do so effectively is not available at this time. Experienced planners will draw from their own expertise to construct menus that are more likely to meet nutrient adequacy goals, but research that uncovers the relationship between offerings and intakes in various planning contexts is needed.

Planning Menus for Nutrients with an Adequate Intake

For nutrients where there is insufficient evidence to determine an Estimated Average Requirement, an Adequate Intake (AI) has been established. The AI is expected to maintain a defined nutritional state or criterion of adequacy in essentially all members of a healthy population. The AI has been estimated in a number of different ways (IOM, 1997, 1998a, 2000b, 2001, 2002a). In some cases the AI is based on the observed mean intakes by groups that are maintaining health and nutritional status consistent with meeting requirements. In these cases the AI is similar conceptually to the median of a target usual nutrient intake distribution. In other cases the AI is the level of intake at which subjects in an experimental study met the criterion of adequacy. In these cases the AI is not directly comparable to a target median intake.

Because the derivation of the AI differs substantially among nutrients and among age and gender subgroups, it also is the case that its use in planning group diets varies. The AI can be used as a planning goal as the target median intake of a group if the variability in usual intake of the target population is similar to the variability in intake of the population used to set the AI. However, if the AI is not based on a group median intake of a healthy population, plan-

ners must recognize that there is a reduced level of confidence that achieving a median intake at the AI will result in a low prevalence of inadequacy. Furthermore, the AI cannot be used to estimate the proportion of a group with inadequate intakes (IOM, 2000a). Thus, regardless of how the AI has been estimated, it is not possible to use the AI to plan a target distribution of usual intakes with a known prevalence of inadequacy.

Table 3-5 presents a summary of the nutrients for which AIs have been estimated, and notes the cases in which these estimates reflect group mean intakes. The comparability of the target group to the population used to set the AI can be verified by referring to the original DRI reports for the nutrients of interest.

Assessing the Results of Planning

The final step in planning intakes is to assess the effectiveness of the planning process. Such an assessment would follow the recommended procedures for assessing group intakes (IOM, 2000a). There are several reasons why assessment is a crucial component of the framework for group planning. First, planners typically can control only what is offered to individuals in the group, not what they actually eat. Because the goal of planning is to achieve an acceptable group prevalence of inadequacy, then it is clear that to judge the success of the planning activity, intake assessment must occur.

Furthermore, the distribution of intakes that was chosen as the starting point for the planning activity often will not be taken from the group for which intakes are being planned. For example, it may be necessary to start with intake distributions from national surveys. Thus, the planner is making an assumption about the applicability of the distribution to the group of interest.

In addition, a crucial assumption is made when establishing the targets for planning—that shifting the distribution of intakes to a new position does not change the shape of the distribution. If the shape changes, then the estimated target percentiles (including the median) of intake may be incorrect. The shape of the distribution is likely to depend on many factors, including food preferences, the types of foods served, and the amount of food needed to meet each person's energy needs. Thus, there are several reasons to believe the distribution's shape would change if a different selection of foods is served.

Planning group diets is an iterative, ongoing effort in which planners set goals for usual intake, plan menus to achieve these goals,

TABLE 3-5 Nutrients with Adequate Intakes

Nutrient	Life Stage Group	Group Mean Intake
Total fiber	1–18 y	No
	19–50 y	No
	> 50 y	No
	Pregnancy and lactation (all ages)	No
n-6 Polyunsaturated fatty acids	0-12 mo	Yes
	1–18 y	Yes
	19–50 y	Yes
	> 50 y	Yes
	Pregnancy and lactation (all ages)	Yes
n-3 Polyunsaturated fatty acids	0–12 mo	Yes
	1–18 y	Yes
	19–50 y	Yes
	> 50 y	Yes
	Pregnancy and lactation (all ages)	Yes
Calcium	0–12 mo	Yes
	1–18 y	No
	19–50 y	No
	> 50 y	No
	Pregnancy and lactation (all ages)	No
Fluoride	0–12 mo	Yes
	1–18 y	Yes
	19–50 y	Yes
	> 50 y	Yes
	Pregnancy and lactation (all ages)	Yes
Magnesium	0–12 mo	Yes
Phosphorus	0–12 mo	Yes
Selenium	0–12 mo	Yes
Biotin	0–12 mo	Yes
	1–18 y	No
	19–50 y	No
	> 50 y	No
	Pregnancy and lactation (all ages)	No
Choline	0–12 mo	Yes
	1–18 y	No
	19–50 y	No
	> 50 y	No
	Pregnancy and lactation (all ages)	No

continued

TABLE 3-5 Continued

Nutrient	Life Stage Group	Group Mean Intake
Folate	0–12 mo	Yes
Niacin	0–12 mo	Yes
Pantothenic acid	0–12 mo	Yes
	1–18 y	Yes
	19–50 y	Yes
	> 50 y	Yes
	Pregnancy (all ages)	Yes
	Lactation (all ages)	No
Riboflavin	0–12 mo	Yes
Thiamin	0–12 mo	Yes
Vitamin B_6	0–12 mo	Yes
Vitamin B_{12}	0–12 mo	Yes
Vitamin C	0–12 mo	Yes
Vitamin D	0–12 mo	No
	1–18 y	No
	19–50 y	No
	> 50 y	No
	Pregnancy and lactation (all ages)	No
Vitamin E	0–12 mo	Yes
Vitamin A	0–12 mo	Yes
Vitamin K	0–12 mo	Yes
	1–18 y	Yes
	19–50 y	Yes
	> 50 y	Yes
	Pregnancy and lactation (all ages)	Yes
Chromium	0–12 mo	Yes
	1–18 y	Yes
	19–50 y	Yes
	> 50 y	Yes
	Pregnancy and lactation (all ages)	Yes
Copper	0–12 mo	Yes

continued

TABLE 3-5 Continued

Nutrient	Life Stage Group	Group Mean Intake
Iodine	0–12 mo	Yes
Iron	0–6 mo	Yes
Manganese	0–12 mo	Yes
	1–18 y	Yes
	19–50 y	Yes
	> 50 y	Yes
	Pregnancy and lactation (all ages)	Yes
Molybdenum	0–12 mo	Yes
Zinc	0–6 mo	Yes

SOURCE: IOM (2000a, 2002a).

assess whether the planning goals were achieved, and then modify their planning procedures accordingly.

PLANNING INTERVENTIONS TO CHANGE THE SHAPE OF THE INTAKE DISTRIBUTION

In the above approach to group planning, the implicit assumption is that the shape of the usual intake distribution is relatively stable and that planning for group feeding simply involves determining the location of the usual intake distribution. However, many interventions will also alter the shape of this distribution, either intentionally or unintentionally.

Desired changes in the shape of the intake distribution might be to shrink both tails of the distribution or to shrink only the lower or upper tail. Interventions targeted to only those in the lower tail, if successful, would reduce the prevalence of inadequate intakes, while interventions targeted to those in the upper tail would reduce the prevalence of excessive intakes. An intervention to reduce the total variance in usual intakes might reduce the prevalence of both inadequate and excessive intakes. Several types of interventions might be designed to change intake distributions. For example, food fortification programs might select foods that are consumed more by the targeted portion of the group. Nutrition education classes might be

held for the proportion of the group particularly at risk of low intakes (perhaps those with less education or those who choose not to eat certain types of foods). Food and nutrition assistance programs target low-income families on the assumption that they are at higher risk of inadequate intakes. Some of these applications are discussed in Chapter 5.

It is not surprising that even perfectly planned interventions may not result in the expected changes in intake. Unfortunately, limited guidance can be offered to planners at this time because detailed examinations of the impact of various types of interventions on the shape of an intake distribution are almost nonexistent. Further research is clearly needed to guide planners when selecting intervention approaches.